STATEMENT OF ALBERT P. ALBRECHT, ASSOCIATE ADMINISTRATOR FOR ENGINEERING AND DEVELOPMENT, FEDERAL AVIATION ADMINISTRATION, BEFORE THE HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY, SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS CONCERNING THE FAA AIRCRAFT SEPARATION ASSURANCE PROGRAM. MARCH 31, 1981

Mr. Chairman and members of the subcommittee, I am pleased to have the opportunity to testify at these hearings and to provide you with a report on the progress FAA has made over the past two years on its Aircraft Separation Assurance Program. Before proceeding, I would like to introduce the others who are here with me who have also been personally involved in guiding the direction of this program. Mr. Neal Blake, Deputy Associate Administrator for Engineering and Development; Dr. Edmund Koenke, Acting Deputy Director, Office of Systems Engineering Management; Mr. Norman Solat, Division Chief, Communications and Surveillance Division of our Systems Research and Development Service; and Dr. Clyde Miller, Chief of our Separation Systems Branch.

We have prepared a very short movie illustrating the various elements in a separation assurance program. It is being used at the ICAO Communications Divisional Meeting now going on in Montreal and would, I believe, help to clarify much of what you will hear during the Hearing. With your permission, we would like to show it to you now, after which I will proceed with my statement.

In June of 1979 we provided this committee with an indepth presentation of the history and rationale which forms the basis for our Aircraft Separation Assurance Program. The history is long and the rationale is complex and in the interest of time, rather than replow old ground, I would like to take this opportunity to provide you with a status report on our program.

As you know, our approach to collision avoidance is an integrated combination of operational procedures and technical systems which together can do what no single "black box" can--to reduce the risk of mid-air collisions to a very low level. It consists in part of airspace in which all participants are offered services and/or obliged to participate in the process of reducing risk. Additionally, there are the technological systems, such as Conflict Alert, Conflict Resolution, the Discrete Address Beacon System (DABS) and its data link, the Automatic Traffic Advisory and Resolution Service (ATARS), the Active Beacon Collision Avoidance System and the Full Beacon Collision Avoidance System. It is important, however, to emphasize that the air traffic control system, as it operates today and as it is envisioned to evolve in the future, remains and will remain the basic separation service. The technological systems which I have just mentioned, with the exception of DABS and its data link, serve primarily as a backup to the basic air traffic control system. Conflict Alert and Resolution are aids to the controller to assist him in providing a highly reliable separation service while ATARS and BCAS are designed primarily to assist the pilot in avoiding collision, should the basic ATC system fail. DABS and its data link, however, play a dual role. In its primary role, DABS will provide the basic source of surveillance information to the ATC system and its data link will be used to significantly enhance basic ATC services. In its secondary role, DABS will provide the basic source of surveillance information to the Automatic Traffic Advisory and Resolution Service and the DABS data link will be used to automatically transmit traffic advisories and resolution advisories to properly equipped aircraft.

I will now present a detailed status report on each technological element of the Aircraft Separation Assurance program.

- Conflict Alert - Conflict Alert is an enhancement to the ground computer system designed to warn controllers that violation of ATC separation minima are likely to occur within a prescribed look-ahead time, which varies from 2 minutes in the en route environment to a nominal 40 seconds in the higher density terminal environments. The Conflict Alert function issues a warning to the controller in the form of flashing data blocks and a Conflict Alert Message. In order for Conflict Alert to warn of potential conflict in terminal areas, both aircraft must have altitude-reporting transponders. In the en route system, altitudes can be entered manually into the computer by the controller.

  Conflict Alert has been implemented at all en route Air Traffic Control Centers and at all of the FAA's

61 basic Terminal ARTS III sites. New York and Tampa, both ARTS III A sites, are scheduled for implementation in July and October 1981, respectively.

- Conflict Resolution - Conflict Resolution is another ground computer enhancement now under development for possible implementation in en route areas. It will provide controllers with alternative instructions for resolving conflicts discovered by Conflict Alert. Because of the shorter look-ahead times and the requirement for coordination between advisories delivered to the controller and those delivered automatically to the aircraft by the Automatic Traffic Advisory and Resolution Service (ATARS), it is not anticipated that Conflict Resolution will be implemented in the terminal areas. In those areas, the equivalent function will be performed by ATARS.

  The functional requirements and logic specification for Conflict Resolution have been developed. Software development is scheduled to begin in December 1981. The Technical Data Package for Conflict Resolution is scheduled for June 1983 with first implementation expected toward the end of 1984. Full en route implementation of Conflict Resolution is scheduled for mid-1985; however, the decision to implement is highly dependent on the availability of en route computer resources in the current 9020 computer system.

- <u>The Discrete Address Beacon System (DABS)</u> - DABS is a totally compatible upgrade of today's Air Traffic Control Radar Beacon System (ATCRBS). DABS transponders will operate with ATCRBS interrogators, ATCRBS transponders will operate with DABS interrogators, and DABS and ATCRBS interrogators can be located in the immediate vicinity of each other without degrading the performance of either.

  First, DABS provides a significant surveillance accuracy improvement over ATCRBS. Its discrete address capability also eliminates the interference effects known as "garble," to which ATCRBS is currently susceptible. Second, the DABS air-ground-air "data link" capability allows considerable information to be sent between the ATC system and any individual aircraft, by assigning each aircraft its own discrete identity code or address, to which the information is then attached.

  Automatic ATC services planned for those aircraft equipped with a DABS transponder and a suitable display include clearance confirmation and Minimum Safe Altitude Warnings. However, service offered to aircraft equipped only with ATCRBS transponders will not diminish from present levels. One of the more important services offered to suitably equipped aircraft will be the Automatic Traffic Advisory and Resolution Service which depends upon the improved surveillance capability of DABS for both collision detection and computation of resolution advisories and also depends upon the DABS data link for automatic transmission of traffic and collision resolution advisories.

A Technical Data Package for DABS was published in April 1980.

A U. S. National Standard for DABS was also published in December 1980.

The RTCA Special Committee 142 charged with developing the Minimum Operational Performance Standards for DABS was established in March 1980 and is expected to publish the MOPS in July 1981.

Subject to a decision by the Administrator to implement DABS, the first production unit of DABS can be delivered in 1987 with implementation of the first 90 units completed by the end of 1991.

- The Automatic Traffic Advisory & Resolution Service - The Automatic Traffic Advisory & Resolution Service (ATARS) is basically a software package added to the DABS computer which uses surveillance data from DABS sensors, computes traffic advisory and maneuver instructions in a dedicated ground computer system, and delivers these advisories to the aircraft via the DABS data link. ATARS ground equipment consists of the DABS sensor, the colocated computer, and equipment to interface with the ATC facilities servicing airspace covered by DABS sensors. ATARS service is thus limited to airspace covered by DABS sensors.

  Aircraft equipped with an altitude-encoding DABS transponder and an ATARS display receive protection against all other aircraft having ATCRBS or DABS altitude reporting transponders.

  ATARS-equipped aircraft receive a sequence of separation services. First, advisories are issued concerning proximate aircraft, in which the information is displayed to aid the pilot in visual acquisition. Second, advisories are issued concerning those proximate aircraft which pose a potential threat to aid the pilot in evaluating the threat so that he may avoid a conflict. Finally, in a threat situation in which the computer projects a collision or near miss, one or both of the aircraft receive a resolution advisory approximately 20-30 seconds before the time of closest approach.

The development schedule for ATARS anticipates the publication of a Computer Program Functional Specification in June 1981. A final test and evaluation report is scheduled for December 1982; however, first implementation of ATARS must wait on DABS and cannot be expected before 1988 and again depends on the Administrator's decision to implement.

- <u>Active BCAS</u> - Active BCAS is conceptually the simplest of the ASA program elements. It operates by interrogating transponders in other aircraft similar to a ground radar interrogator. Information relating to range, range rate, altitude and altitude rate of proximate aircraft is derived from the replies to these active interrogations. When the on-board Active BCAS computer recognizes the existence of a collision threat, it generates a resolution command and delivers it to the BCAS display and will provide an aural warning for alert.

  Only vertical maneuver instructions and vertical speed limits are issued. However, as a later enhancement, FAA is pursuing a development effort to supply Active BCAS with a moderately accurate directional antenna, capable of supporting a display of adjacent traffic.

  Active BCAS will provide protection against aircraft equipped with the current altitude-encoding transponders, as well as those aircraft equipped in the future with the altitude-encoding DABS transponder. For multi-aircraft encounters <u>between</u> BCAS-equipped aircraft, maneuver instructions provided to the pilot of each aircraft will be coordinated. This BCAS-to-BCAS coordination is built into the BCAS computer and accomplished via the BCAS air-to-air data link capability, using a standardized DABS message format.

Reliable target tracking for Active BCAS becomes difficult in high density environments, due to the high probability of near-simultaneous reception of a large number of replies. We should note this is also true in every other system or concept presented for review during the past ten years. Analysis has shown that due to electronic interference, the Active BCAS may be limited in operation to environments where average traffic densities of ATCRBS equipped aircraft are fewer than six aircraft within a 10 nautical mile radius of the BCAS aircraft, and where short-term peak densities are less than 18 aircraft within that same radius. For DABS equipped aircraft, the permissible traffic density is appreciably higher, and saturation in the DABS mode is not expected.

In October 1980, a final U. S. National Aviation Standard for Active BCAS was published for public comment.

The RTCA Special Committee SC-147 was established on November 19, 1980, to provide Minimum Operational Performance Standards by February 1982.

In January 1981 FAA held a public conference to present the status of the BCAS program and to describe the results of the BCAS flight tests. BCAS has been flown for about 250 hours of flight test in 18 major terminal areas including Washington, New York, Atlanta, Miami, San Francisco, San Diego, Denver, Houston and Los Angeles. During these tests, some 240 BCAS unit encounters were experienced. In every case, except for Los Angeles, all alerts were timely and correct. In Los Angeles, 3 of 16 alerts were late, one of which was very late. It must be pointed out, however, that this performance degradation was expected because of the high densities of traffic in Los Angeles. This is the very reason that highlights the need for ATARS and Full BCAS.

In March 1980 a contract for 3 Active BCAS units was awarded to Dalmo Victor. These units, one of which will be furnished with a directional antenna, are in the process of factory acceptance testing. These units will be used for air carrier operational evaluation.

Based on approval by the Administrator, certified BCAS avionics are expected to be available during calendar year 1983.

o <u>Full BCAS</u> - The Full Capability BCAS, or more simply, Full BCAS, is a multi-modal airborne collision avoidance system which uses different modes to track proximate aircraft in a number of different environments. While Full BCAS can actively interrogate other aircraft in low density environments in the same manner as Active BCAS, its principle advantage is in its use of passive modes, and combinations of passive and active modes. This will allow it to operate successfully in all environments and with all configurations of ground and airborne equipment. However, its complexity, and therefore relatively high user cost may limit its application to air carriers or other similarly equipped aircraft.

Full BCAS is able to derive accurate bearing information on intruding aircraft. Full BCAS is therefore capable of providing traffic advisories which include bearing, range and altitude, and of generating horizontal and vertical maneuver instructions. For the same reason, BCAS can become a data source for a cockpit display containing traffic information.

Full BCAS will provide protection against aircraft equipped with altitude-encoding ATCRBS or DABS transponders as well as ATCRBS transponders without altitude encoders.

As with Active BCAS, it will coordinate its maneuver commands with other BCAS-equipped aircraft via its air-to-air data link, using standardized DABS messages. In an encounter between an aircraft equipped with a Full BCAS and one with Active BCAS, the maneuver commands generated by each are designed to be fully compatible, thus assuring a future environment where Active and Full BCAS equipments may co-exist.

A contract was signed on January 14, 1981, with Bendix Corporation initiating the development of the Full BCAS. The major milestones for BCAS are:

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| Delivery of 3 Engineering Models | 2/83 |
| Draft National Standard | 10/83 |
| Delivery of up to 20 Prototypes | 8/84 |
| Full BCAS Final Report | 5/85 |

The decision to implement Full BCAS will, of course, be made by the Administrator.

As you can see, our technical progress in ASA has been substantial over the past two years. I would like now, in the time remaining, to also report to you on the status of several important issues which were raised and reported on during this subcommittee's hearings on CAS in 1979.

- o ACAS vs. BCAS - First, I would like to assert that FAA is confident that the decision it made in 1976 to reject ACAS and pursue BCAS was correct and proper. In 1975 FAA estimated that ACAS protection would not be available until the 1983-84 time period assuming that it was possible to solve the regulatory problems and the technical problems associated with ACAS such as false alarms, radar altimeter interference, ATC compatibility and general aviation equippage. No information has been presented to date to change that appraisal. Certified Active BCAS units can be available during calendar year 1983, and would provide immediate protection to the first user.

o Full BCAS vs. Tri-Modal BCAS - In 1978 FAA decided to pursue Full BCAS rather than the Tri-Modal BCAS proposed by Litchford Electronics. Again, I would like to assert that this decision was correct and proper and that it has been substantively supported by NASA. NASA's findings have been documented in their May 1980 report SX-81816 for the FAA in direct response to the House Subcommittee on Transportation Appropriations instruction to FAA in June 1979 to ". . . contract with NASA for an evaluation and test of the tri-modal beacon collision avoidance system."

The major findings from this evaluation were:

A. "It has been demonstrated that T-BCAS has the capability of making the basic measurements required of a BCAS in an ATCRBS environment, but T-BCAS is not fully developed and has not been thoroughly evaluated either via analysis, simulation, or flight tests. Furthermore, results to date show that there may be some significant problems which must be overcome for the system to operate in all environments.

B. Further flight tests of T-BCAS as it is currently implemented (L2CAS11) would not provide the engineering data necessary to fully evaluate the T-BCAS concept.

C. The T-BCAS is incompatible with a DABS environment."

o <u>International</u> - The last point I would like to mention is directed at the question of the International Civil Aviation Organization (ICAO) approval.

DABS and BCAS are compatible with the existing ICAO approved Radar Beacon system. In order to foster international cooperation in this area, FAA has specific agreements with the United Kingdom and the USSR for the development of DABS. We have also been working with France and the Eurocontrol member states toward compatible system development and eventual international standardization of the signal characteristics. FAA has also been working with the Japanese, who have research programs in CAS, to insure that their research is compatible with our development efforts.

ICAO has had a long-standing interest in the subject of collision avoidance. In 1972 ICAO adopted a set of operational requirements pertaining to CAS. The U. S. BCAS development meets all of these requirements. Starting yesterday, March 30, and for the next three weeks, the ICAO Communications Divisional Meeting is taking place in Montreal and the subject of collision avoidance is an agenda item at that meeting. FAA will present the status of its developments as will other nations. We expect that this exchange of views will help pave the way for international standardization if and when it is considered appropriate by the international community. It should be noted, we have no control over foreign decisions to include BCAS, or any other system, in their airspace.

I should note one other item for the Committee. The Administrator-Designate has started an in-depth review of both the functional and implementation requirements of our collision avoidance system and separation assurance program. This review, based on our meetings to date and questions he has already asked, will be very probing. I am confident he will discuss his findings and conclusions with the Committee at the appropriate time.